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Australian apprenticeships: trends, challenges and future opportunities for dealing with Industry 4.0

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National Centre for Vocational Education Research

INFORMING POLICY AND PRACTICE
IN AUSTRALIA'S TRAINING SYSTEM

Publisher's note

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Abstract

The Australian economy is in transition. Its future prosperity will depend on greater economic diversification and on innovation and entrepreneurship, hallmarks of Industry 4.0. This has implications for skills development for future workers and for those needing to move into new jobs or roles. It also has a direct impact on apprenticeships — an enduring and well-respected feature of Australia's skill-development landscape. It is concerning then that overall apprenticeship commencements and completions have been declining.

What impact does Industry 4.0 have on the future of Australian apprenticeships? This paper was presented to the 4th KRIVET International Apprenticeships conference in Seoul, Korea, 28th September, 2017, and explores the challenges and constraints in the capacity of the Australian system of apprenticeships to respond adequately to Industry 4.0. It also covers directions in government policy, and the opportunities to create change found within industries and the training system itself.

Introduction

Setting the scene: Australia's economic and policy context

The Australian economy is in transition. Of significant impact has been a decline in the mining investment boom, coupled with the loss or redesign of jobs in the automotive manufacturing industry, as well as a more general decline in the traditional manufacturing industry in Australia (Stanwick, Circelli & Lu 2015).

As Stanwick, Circelli and Lu (2015) identify, manufacturing's relative contribution to Australia's economic output has been steadily declining, a common trend among developed countries (Australian Workplace and Productivity Agency 2014). Manufacturing's share of gross domestic product (GDP) declined from 13.2% in 1975 to 6.6% in 2013, while in the same period mining's share of GDP rose from around 6.5% to 10% (Australian Workplace and Productivity Agency 2014, p.31). Further, labour force data from the Australian Bureau of Statistics (ABS) highlight that, in the 10-year period from May 2005 to May 2015, the total number of people employed in the manufacturing industry declined from 10.4% of all employed people to 7.8% (ABS 2015a, 2015b). The reasons for the decline in employment numbers are many, but encompass technological advances (for example, robotics and automation of manufacturing processes), changes in consumer preferences and in government policies (Bradley 2015).

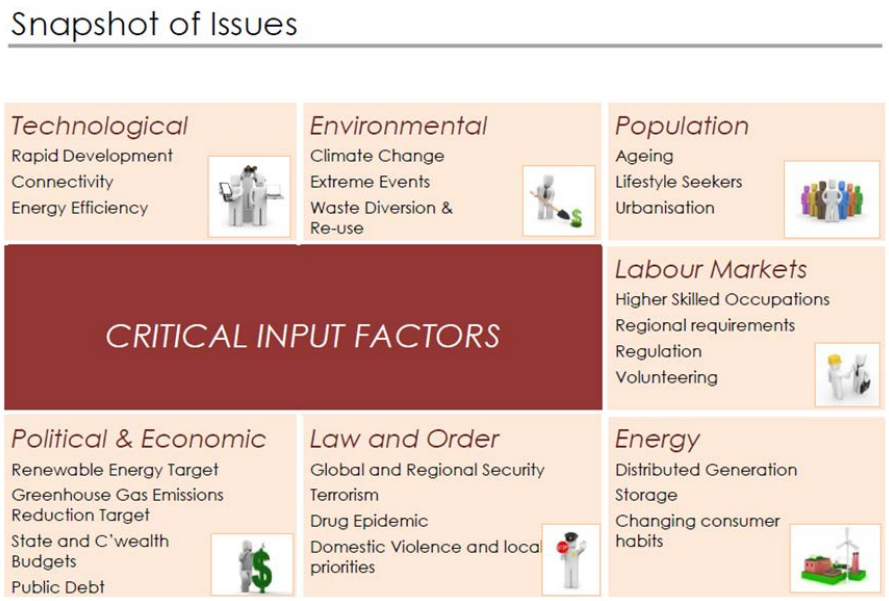
The competitiveness of Australian companies in the future will be largely determined by the scope and penetration of new and yet-to-be-developed technologies and how professionally and consistently they are utilised. It will also depend upon companies embracing a holistic approach across their value chain (Lilly, cited in Couldrey & Loveder 2017). This has implications for the types of skills needed in the labour market, as future prosperity will depend on greater economic diversification, innovation and entrepreneurship. These factors also have consequences for skills development for future workers, and for existing workers needing to move into new jobs or roles, including apprenticeships.

Snapshot: Advanced manufacturing technologies: industrial robotics and where Australia is placed

The number of industrial robots deployed worldwide will increase to around 2.6 million units by 2019. Broken down according to sectors, around 70% of industrial robots are currently at work in the automotive, electrical/electronics and metal and machinery industry segments. In 2015, the strongest growth in the number of operational robotic units recorded in Australia was registered in the electronics industry, which boasted a rise of 18%. The metal industry had an increase of 16%, with the automotive sector growing by 10%. It is interesting to note that the number of industrial robots per 10 000 employees in the manufacturing industry is 531 in Korea, 398 in Singapore, 305 in Japan, 301 in Germany, 212 in Sweden – as the top five users. Australia, by comparison, is close to the global average of 69 (International Federation of Robotics 2016; Roos 2017).

Australia's physical climate is also changing and the population is ageing, driving labour and skill demand in the community and health services sector, as well as in the finance and insurance services and the energy and utilities sectors. The world is also becoming more globally interconnected, providing opportunities for new markets for Australian goods and services, particularly in the areas of food, education and tourism, as well as exposing threats in areas of biosecurity, cyberspace and terrorism (figure 1).

Figure 1 Critical factors affecting industry



Source: Electrical Utilities and Public Administration Training Council Industry Workforce Development Plan (UEPA 2016, p.5).

In 2015 the Committee for the Economic Development of Australia (CEDA) saw Australia as on the cusp of a new industrial revolution. It examined the implications of rapid and continuing technological change on Australia's future workforce and predicted (Durrant-Whyte et al. in CEDA 2015, p.58) that up to 40% of jobs in Australia could be susceptible to computerisation and automation in the next 10 to 15 years. Jobs in administration and some services are particularly susceptible, as are regions historically associated with the mining industry. Jobs in the professions, in technical and creative industries, and in personal service areas (health, for example) are least susceptible to automation.

Industry is being transformed by technology, which is also breaking down traditional sectoral divisions. For example, mining equipment, technology and services (METS) companies have developed ways to smooth fluctuations in the mining lifecycle, with offsetting income sources, diversifying by transferring their skills to other sectors such as renewables, defence, marine and infrastructure (Austmine 2013, p.7). Standard industry groupings are also being broken down by the rising importance of these services.

All this has implications for workers, who have to become more autonomous, manage their careers (and continuing education) and rely more on entrepreneurial skills. Employees are also being asked to become more creative, as well as more technically proficient, so they can perform well in the digital age (Beitz in CEDA 2015, p.161).

Others in the vocational education and training (VET) sector, such as the building and construction industry, remind us we are easily distracted by notions of rapid innovation, and change and skilling for tomorrow (Siekmann and Korbel 2016). While it is important to consider the future, the primary concern for many industries is adequate skilling for today.

Whether you choose an optimistic or pessimistic response to these trends, one thing is clear: Australians will need higher and different skills to operate both in the current labour market and beyond. As Megan Lilly, Head of Workforce Development for the Australian Industry Group (Ai Group) adroitly puts it 'we need to retool the nation' (cited in Couldrey & Loveder 2017, p.26). Lilly further notes:

> Developing new and different skills utilising the right digital technology will be vital. This has major implications for our education and training provision, as well its intersection with work. The apprenticeship system sits neatly in this space. It is capable of providing a high-quality, fully integrated learning and employment experience at the leading edge of economic transformation. The education and training system should not always have to chase the future; it should be part of it. (Lilly in Couldrey & Loveder 2017, p.26).

Setting the scene: latest apprenticeship data

The latest release by the National Centre for Vocational Education Research (NCVER) of apprentice and trainee data show there were 275 200 apprentices and trainees in-training as at 31 March 2017, a decrease of 3.7% from 31 March 2016 (NCVER 2017). This equates to 2.3% of Australian workers who are employed as an apprentice or trainee (NCVER 2017).

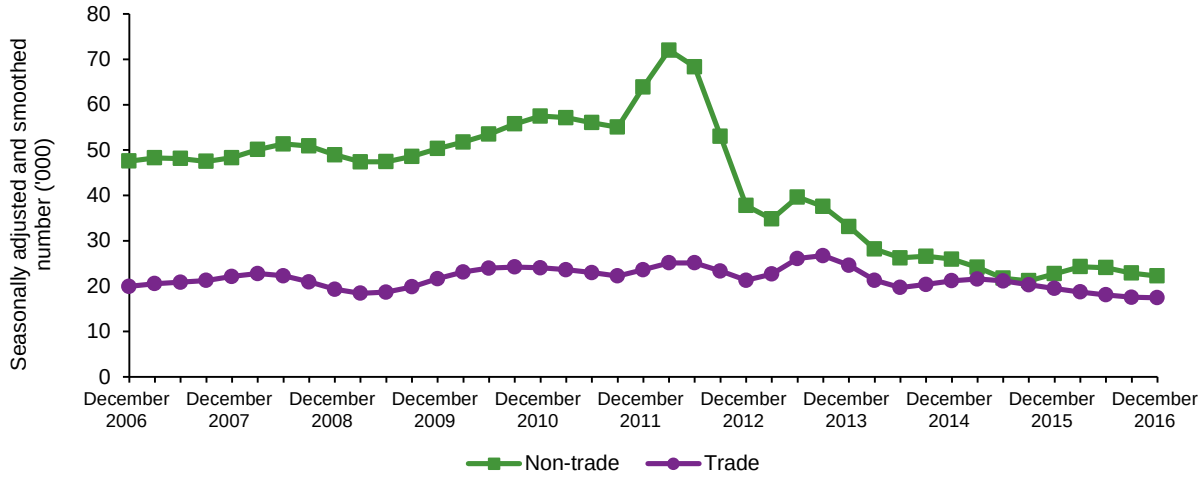
In the 12 months ending 31 March 2017, compared with the 12 months ending 31 March 2016:

- commencements decreased by 1.9%, to 166 700
- completions decreased by 15.1%, to 97 300
- cancellations and withdrawals decreased by 0.5%, to 93 400.

For trade apprentices alone, in the 12 months ending 31 March 2017, compared with the previous 12 months, trades commencements decreased by 9.0%, to 72 300, and completions decreased by 13.2%, to 43 800 (NCVER 2017).

For the first time since 1996, the decline in the number of non-trade apprentices has resulted in converging proportions of trade and non-trade apprenticeship commencements (figure 2).

Figure 2 Quarterly commencements for trade and non-trade occupations, seasonally adjusted and smoothed, 2006–16 ('000)



Source: NCVER (2017).

Structural changes to the economy and the make-up of Australian industries, the changing nature of work, supply and demand factors, as well as policy, inevitably impact on the ebbs and flows in apprenticeship data. It is also important to appreciate the nuance in these data. Separating apprenticeships (mostly trade) from traineeships (mostly non-trade) is not ideal for suitable comparisons as there are jurisdiction variations in their definitions. It remains to be seen whether the responses developed to address the challenges of today and the foreseeable future will be sufficient.

They will need to counteract the shifting demand for, and interest in, apprenticeships over the next 20 years and ensure that they remain an effective skill-development model.

Snapshot: Advanced manufacturing and access to leading edge technologies[1]

In August 2017, engineering giant Siemens announced a record $135 million industrial software grant for the Swinburne University of Technology to create Australia's first fully immersed Industry 4.0 facility. The grant will be used to digitize Swinburne's Factory of the Future, giving students and researchers access to the same apparatus used by leading companies on advanced projects in the highly competitive digital manufacturing sphere. This will assist with preparing students to participate fully in the emerging global innovation economy.

1 <http://www.australianmanufacturing.com.au/46568/siemens-announces-135m-grant-to-digitalise-swinburnes-factory-of-the-future>.

Changes to apprenticeship governance and delivery relating to future industry needs

Broader government initiatives

Industry 4.0 Taskforce

> Australia should see the fourth industrial revolution as an opportunity. If we establish a broad-based capability to use global engineering and manufacturing platforms based on advanced materials, the often spruiked access by our [small- and medium-sized enterprises] SMEs to global supply chains are more a reality now than they have been at any time in the past.
>
> Jeff Connolly, Chair of the Prime Minister's Industry 4.0 Taskforce

On 25 April 2017 the Prime Minister's Industry 4.0 Taskforce signed a cooperation agreement with Platform Industrie 4.0 (Germany).[2] The agreement fulfils a recommendation by the Australia—Germany Advisory Group to increase collaboration on digital transformation. The agreement also forms part of the broader cooperation between Australia and Germany on science and innovation. Platform Industrie 4.0 and the taskforce have agreed to cooperate across five work streams, representing key challenges in the transition to Industry 4.0:

- reference architectures
- standards and norms
- support for small- and medium-sized enterprises (SMEs)
- Industrie 4.0 test beds
- security of networked systems
- work, education and training.

This cooperative work will be supported by government, industry, and standards and research organisations in both countries, with the Advanced Manufacturing Growth Centre coordinating work in Australia.

Under the 'work, education and training' stream, the initiative recognises that digital skills are the key factors in the competitiveness of industry in both countries. There is a need to promote digital skills in vocational education and training as well as in on-the-job training in order to make employees ready for the age of digital transformation. The key action items are not directly or specifically linked to apprenticeships per se, but they will focus on sharing information on and best practices in work, education and training in sectors relevant to Industry 4.0 and will aim to facilitate cooperation on digital re-education for existing employees (Australian Government 2017).

2 <https://industry.gov.au/industry/Industry-4-0/Pages/PMs-Industry-4-0-Taskforce.aspx>.

Reducing ‘red tape’ and business simplification

More recently, at a meeting held on 4 August 2017, the Council of Australian Governments (COAG) agreed to two key broader initiatives (COAG Industry and Skills Council 2017):

- Regulatory frameworks need to be responsive to change, reduce barriers and minimise red tape, within an industry environment where technological innovation and disruptive business models are displacing established firms, products and alliances and at the same time potentially providing more consumer choice and improved products and services. Ministers discussed a specific reform opportunity to be reviewed as a matter of priority out of session. Ministers agreed to adopt principles to guide nationally consistent approaches to regulating technical innovation and disruptive business models. Jurisdictions have been proactive in addressing the regulation of new technologies, and ministers noted the inter-jurisdictional collaboration under way in these areas.
- The National Business Simplification Initiative is concerned with making regulation less complex for businesses and streamlining business interaction with all levels of government. Ministers and officials from all jurisdictions met in November 2016 and agreed to work together to make it simpler to do business in Australia under the National Business Simplification Initiative. All jurisdictions agreed to continue working together on business simplification and that simplifying the process of employing a person was a national business-simplification priority. Ministers further agreed to prioritise working together to reduce the burden on small business. The reasoning is that small business has a widespread impact, diffusing across the Australian economy. If it is easier for these small businesses to employ staff, owners might not think twice about hiring an additional person. If one out of every 50 small businesses currently without employees started employing just one person, this could create 25 000 jobs.

Australian policy response with an apprenticeship focus

To the question: *Is the Australian apprenticeship model well placed to meet the challenges of developing skills in this rapidly changing world*?, Megan Lilly, Head of Workforce Development at Ai Group, offered the following response:

> I would contend that the core principles of the apprenticeship model are well placed to develop many of the skills required into the future, but I am less confident that our apprenticeship system is up to the task. (Lilly in Couldrey & Loveder 2017, p27)

The current Australian Government’s championing of innovation has put a more intense spotlight on skill requirements in response to Industry 4.0. However, there have been no significant modifications to apprenticeship governance arrangements that take into account the needed governance changes for Industry 4.0.

Many reviews have been held in the area of apprenticeships over recent years and there is a solid base of research that identifies some of the critical factors, both in Australia and internationally. Recently, major reports in Queensland (Jobs Queensland 2016) and New South Wales (NSW Business Chamber 2016) clearly state some of the factors important to reinvigorating apprenticeships, including:

- early apprenticeship participation
- sound industry-led career advice
- restoring consistency in delivery and coordination
- an outcomes focus to the system.

However, there are still questions surrounding the future success of the system. Many participants at the *Future of Australian Apprenticeships Stakeholder Forum* expressed the need for a more comprehensive analysis which could give an understanding of the system factors that are both most open to influence and which are able to be changed. They pointed out that this understanding would assist in informing cost-effective interventions at the right time (Couldrey & Loveder 2017).

Two recent Australian government policy papers are of some interest:

- *A shared responsibility,* the 2011 report *of* Apprenticeships for the 21st Century Expert Panel
- the 2016 *Recommendation report* of the Apprenticeship Reform Advisory Group (ARAG).

The *Apprenticeships for the 21st Century Expert Panel report* acknowledges that the Australian apprenticeships system 'will require significant improvement to performance, such as retention, completion outcomes and its impact on productivity and innovation, if Australia is to respond effectively to the challenges of competing in a global marketplace' (2011, p.8). Yet no specific recommendations were made with respect to governance arrangements.

The *Apprenticeship Reform Advisory Group report* of 2016 is perhaps even narrower, with a focus on three pillars of change:

- a restructuring of incentives
- a new pre-apprenticeships program
- piloting alternative models of apprenticeship delivery.

In response to Industry 4.0, one of those alternative models is to focus on and adopt the concept of *higher apprenticeships*, which is considered in more detail below.

Potential for change in the future

The Australian Government is continuing to explore systemic challenges in the apprenticeships system. PhillipsKPA (an Australian consulting firm) has been awarded a contract from the Australian Government to conduct a number of forums on apprenticeships in 2017—18. The themes of those forums include:

- the impact of the changing nature of work on the apprenticeship model
- the different approaches to the educational model that underpins apprenticeships
- regulation of the apprenticeship system
- program support.

A final forum in May 2018 will draw the outcomes of the earlier four together. It is expected the results, and any subsequent government policy recommendations, will be available in the latter half of 2018.

Funding and targets

The most recent major VET policy initiative by the Australian Government was in May 2017 with the announcement of the *Skilling Australians Fund*, which supersedes the *National Partnership Agreement on Skills Reform*. The Skilling Australians Fund underpins a new partnership between the states and territories and is policy designed to provide ongoing funding for VET. This is primarily through supporting up to 300 000 apprenticeships and traineeships, including pre-apprenticeships and higher-level apprenticeships, and training for occupations in high-demand areas and in rural and

regional Australia. To receive funding, states and territories need to match Commonwealth funding, and make a bid for finance with proposals to align with criteria set by the Commonwealth. The *Skilling Australians Fund* commenced 1 July 2017, with an estimated $1.5 billion being available from 2017—18 to 2020—21.

A focus on mentoring

The Industry Specialist Mentoring for Australian Apprentices program was also introduced in the 2017—18 Budget. It will provide intensive support to apprentices and trainees in the first two years of their training in industries undergoing structural change. The Department of Education and Training intends to appoint well-equipped providers to offer comprehensive mentoring services. More information about the Industry Specialist Mentoring for Australian Apprentices program is available on the Australian Apprenticeships website.

Jurisdiction (state/territory) policy responses with an apprenticeship/ Industry 4.0 focus

The primary focus of skilling and training programs in all jurisdictions is jobs. The provision of apprenticeships and traineeships dominates, with all jurisdictions committing funding to this training-to-work pathway. The nature of the commitments includes:

- The NSW Government has introduced programs and initiatives aimed at increasing the proportion of people completing apprenticeships and traineeships and providing opportunities for young people. These include partnering with group training organisations and industry bodies (through the Apprenticeship Compact), piloting the Local Government Skills Strategy in four NSW regions and the Smart, Skilled and Hired program which works with businesses to provide opportunities for young people and to help young people looking for an apprenticeship or traineeship. In addition, NSW amended its Apprenticeship and Traineeship Act in August with the aim of positioning the state's apprenticeship and traineeship system for the current economy and into the future.
- The Victorian Government has focused on initiatives such as the Major Projects Skills Guarantee which ensures that apprentices and trainees do at least 10% of the work on Victoria's major projects. In addition, the Victorian government recently reported on the outcomes of the Victorian Apprenticeship and Traineeship Taskforce (VSC 2017) which among many options, recommended industry consortia-based apprenticeship pilots focussed on industry sectors where there are clear labour needs and skills gaps.
- The Queensland Government, similarly to Victoria, has specified that to be considered for major government infrastructure contracts, 10% of total labour hours on these projects should be assigned to apprentices and trainees. Projects in Indigenous communities should have an additional 10% of total labour hours committed to providing opportunities for Aboriginal and Torres Strait Islanders and the local economy. This commitment was extended to projects by government-owned corporations and public—private partnerships.
- South Australia continues to support apprenticeships and traineeships in areas of strategic economic importance, and its focus will be informed by the Training and Skills Commission's forthcoming report on Apprenticeships and Traineeships for the 21st Century.
- The Northern Territory Government is committed to helping get Territorians work ready and ensure responsive training programs are aligned to the needs of NT businesses, industries and workers through the Northern Territory Training Entitlement and apprenticeships and traineeships.

- In the ACT, the Government will target funding toward apprenticeships that address areas of priority industry growth, for example, in construction. In addition the government aims to boost the number of female apprentices and upskill mature aged workers to encourage them back into the workforce.
- Apprenticeships and new entrant traineeships are a high priority for the Western Australian State Government. Training for apprentices and new entrant trainees operates under a demand driven user choice arrangement and is subsidised at the highest rate. Recently, the WA government signed an agreement with key employers in the Pilbara district to deliver enhanced employment, education and training opportunities, particularly the development of pathways to job creation; including apprenticeships.
- The Tasmanian Government is focused on assisting Tasmanians to develop technical and work-ready skills in growth industries. It is expected that the skills gained will help young people in particular to secure employment, or an apprenticeship or traineeship, and help meet demand for skilled labour in growth industries. The government is additionally working with small businesses and group training organisations to make it easier to employ an apprentice or trainee, enabling more apprentices and trainees to successfully complete their education and for small businesses to access the skilled workers they need to grow and expand.

Integrating future prospective occupations into apprenticeships

Which competencies are required and which occupations are revised and newly developed?

Currently in Australia a number of frameworks, standards, descriptors and initiatives support the development of the core skills needed to gain and maintain jobs.

An industry-led training products framework remains a cornerstone of the national training system, with industry playing a key role in defining the skills required by the labour market. Training packages are developed through the work of skills service organisations and industry reference committees, under the auspices of the Australian Industry Skills Committee (AISC). Ideally, training packages and their associated products:

- establish occupational standards
- enhance the capacity of learners to enquire and analyse
- support dialogue between industry and educators
- enable effective regulation to support training quality
- encourage lifelong learner involvement and empowerment in the development of skills and knowledge (Beddie, Hargreaves & Atkinson 2017).

The Australian Core Skills Framework and Core Skills for Work Developmental Framework focus on the competencies needed to gain proficiency in non-technical skills. Training packages, which focus on technical or task-specific skill standards (units of competency), also include these core skills for work/employability in units of competency descriptions. In regard to occupational profiles, brief occupation-specific/technical skill descriptions and their level of skill are found in the Australian and New Zealand Standard Classification of Occupations (ANZSCO), although other skill types are not normally covered (Siekmann forthcoming).

The Australian Skills Quality Authority (ASQA) ensures that registered training organisations (RTOs) are meeting the requirements of these industry-developed training packages, so that VET graduates have the required skills and competencies for employment.

Common to all of these is a relatively long, slow update cycle, meaning that crucial changes may be missed in some areas of skills and attitudes, for example, digital skills, communication skills or adaptability and resilience (Siekmann, forthcoming). Indeed, some argue that the model of training packages and training product design is not sufficiently agile or fast enough to meet evolving skill requirements. There is room to raise the speed of update cycle. Others would argue that despite this, the VET sector is ideally placed to respond quickly to the evolving skill requirements of the Australian workforce because it offers shorter courses and because the sector has a very rich history in working directly with industry.

Indeed, the recent proliferation of skills sets attests to this speedy skills response from the VET sector.[3] Since 2009 there has been a rapid increase in the number of skills sets in training packages (table 1), suggesting strong industry support for skills sets as a vehicle for meeting changing workforce skill-development needs. Indeed, several industry skills councils have defended the idea of skills sets and the benefits they provide for upskilling their workforce. They recognise that industry needs to work with RTOs to provide shorter training programs, programs that specifically address gaps in workers' knowledge and recognise existing skills and experience. A manufacturing workforce study also found that short courses or skills sets are the preferred option, as this form of training can be highly customised to efficiently upskill existing staff in new technologies (Hargreaves & Blomberg 2015).

Table 1 Number of skill sets developed across all training packages, 2006–17

Date	2006	September 2009	August 2010	June 2012	June 2014	September 2017
Number of training package skills sets	Assume zero, no definitive data found	178	323	924	1125	1296

Source: <https://training.gov.au/>.

Forecasting demand and emerging skills

The Australian Government's industry innovation and competitiveness agenda outlines a number of ambitious objectives for strengthening Australia's economy, one of which is a more skilled labour force through a focus on reform of the VET sector. The current VET reform agenda is aimed at addressing Australia's needs for a skilled and flexible workforce, one able to adapt to rapid technological change in the workplace and improve the nation's economic position in the face of increasing global competition. This raises questions about how current and future workforce-development needs, at a national or regional level, are balanced with student choice and an increasing demand for tertiary education, and the role of the VET sector in this.

Forecasting emerging skills

Many assumptions and pitfalls underpin the modelling of forecasting emerging skills, given that it is often based on conjectures relating to trends in the economic behaviour of individuals, firms and governments. Data and information may currently be sourced from a number of reputable agencies, for example, the ABS, the Australian Treasury and the Bureau of Resources and Energy Economics (BREE). The magnitude of forecasts is mostly indicative, not prescriptive. Furthermore, Australia does not share the tradition of many other countries (for example, the United States, the United Kingdom, the Netherlands, Canada and the European Union) of producing labour market information on a regular basis, even though it possesses the data (albeit across different sources) to do so (Shah forthcoming).

While the degree of skills mismatch in Australia on average, and by comparison with other countries, is not alarming (indeed a certain degree of mismatch is 'natural' and unavoidable), future developments such as the fourth industrial revolution could quickly exacerbate existing issues. NCVER is therefore undertaking a study that considers the usefulness of international models and initiatives in the field of skill information to correctly identify and disseminate occupational skills in demand.

3 The VET system in Australia uses units of competency as its basic building blocks. Each unit of competency has defined learning outcomes (knowledge, skills and their application parameters), which are measurable in their own right, but which also contribute to larger education outcomes. When units of competency are combined into an interrelated set below the level of a full qualification, they are now commonly referred to as 'skills sets'. Skills sets enable performance of job tasks or functions.

Of particular interest is the detail of occupational skills profiles, their accuracy in regard to labour market reality and the implementation of this skill intelligence in vocational training (Siekmann forthcoming).

To navigate the increasingly complex skill landscape, Australia's availability of, and access to, skill information, both on the supply and demand side, could be further consolidated, streamlined and updated, based on an overarching skill information framework. This could be both particularly useful in updating skill standards in training packages, and also in linking VET-accredited units to skills identified on the demand side (Siekmann forthcoming). Ultimately, the goal is a single portal which brings together a range of data and intelligence to describe occupations more effectively, in terms of skill types and the level of skills proficiency required to target training content and relevance.

In another project, NCVER is working closely with key industry stakeholders (through the Australian Industry Skills Committee and its secretariat), along with the Department of Education and Training, to ensure that broader industry interests in accessing timely and curated labour market and skills information are canvassed and understood. This includes successfully delivering the Annual Industry Insights report portal for the Commonwealth during 2017.

Training for now or the future

A central tension in the Australian vocational education and training model is how do we train for the now and for the future? This was explored at a recent NCVER forum on potential reform to training products, *Evolution not revolution: views on training products reform.* A primary interest of many participants was for any reform efforts to preserve the effective aspects of the current training products while also looking to the future (Beddie, Hargreaves & Atkinson 2017).

> While it is important to have the capacity to understand, to the extent this is ever possible, the future shape of work and the associated skills and knowledge requirements, not everything is new: there are some constants in human behaviour for which the economy and, in turn, the training system must provide. (Beddie, Hargreaves & Atkinson 2017, p.18)

The sixty or so symposium participants in this training products forum pointed out that to train for something *too far into the future* will not serve employers or individuals in today's workplace. With better definition of the fundamentals, gained through further examination and refinement of the proportionate balance between future and current skills required by industry (20:80 for example), it may be easier to both preserve the integrity of nationally accredited training, and build in the flexibility and forward-looking attitude it also requires (Beddie, Hargreaves & Atkinson 2017).

Indeed, in contrast to the majority of submitters to a recent parliamentary inquiry into innovation and creativity, the National Employment Services Association argued against a focus on specific skills, such as STEM (science, technology, engineering and mathematics). They argued that an education system which focuses on context-specific hard skills, to the detriment of the more fundamental requirements of adaptability and communication, does not serve either its graduates or the labour market adaptability requirements, and that the skill gaps created by such a system will only widen with time. Worse, they argue that the downsides of such skill gaps means that, combined with the complex gamble of attempting to second-guess the unknowable future directions of job market evolution by focusing too narrowly on one type of educational stream (such as STEM), could prove to be socially irresponsible (National Employment Services Association 2017).

Skills required for Industry 4.0

In Australia, research by CSIRO highlighted the impact of technology on jobs now and in the future, identifying the implications for the apprenticeship and traineeship system in terms of the knowledge, skills and experience to be acquired by apprentices and trainees and the way in which this occurs. The existing flexibility in the system, as demonstrated by models such as hairdressing and aviation, may need further exploration. The speed with which digital disruption occurs also has implications for the current process for altering or updating accredited VET courses. This necessitates extensive and timely consultation, and may limit the system's ability to respond in a timely manner to changes in workplace practices and skills requirements (Jobs Queensland 2017).

The international skill literature unequivocally documents a major shift towards non–technical skills on the demand side. In vocational training, employability skills, including socio-emotional skills and transferrable skills, will need to be addressed equally with technical skills, if not more so (Siekmann forthcoming).

Goran Roos (2017) suggests that the key skills required for Industry 4.0 will include attributes such as cognitive flexibility and creativity, logical reasoning and mathematical reasoning, as well as critical thinking, emotional intelligence, judgment and decision-making. This has implications for the delivery and assessment of such skills. He argues rather pessimistically that the speed of technological development exceeds the human ability to learn; that is, by the time new knowledge and skills have been learnt they are already obsolete. However, this does not attest to the importance of life-long learning and adaptation. This is only true if knowledge, as claimed, is increasing exponentially (Roos 2016). It fails to acknowledge that technological development has an adoption time frame which can be much slower than the initial knowledge change boundary. This signals a need and urgency for promoting life-long learning in the workforce in order to ensure we stay apace with change.

Internet job-vacancy data provide an up-to-date (although not comprehensive) picture of what is happening in the labour market, offering a succinct account of the skills and attributes employers show they are actually looking for. NCVER is working with Burning Glass technologies to turn this data into insights. A couple of examples of apprenticeship opportunities with Industry 4.0 relevance from the last 12 months are shown in figure 3.

Figure 3 Recent apprenticeship job advertisements

Automated equipment trainees
Wagners: Australia, International

Retail

Wagners Composite Fibre Technologies (CFT) is a world leader in the application and development of composite engineering materials. The CFT vision is to revolutionise the global materials industry by being number one in composites, providing infrastructure with innovative engineered solutions capitalising on the inherent benefits of composites. An exciting opportunity currently exists for those with previous manufacturing or production experience and an interest in: mechanics, robotics and engineering to join our team as automated equipment trainees.

Key duties of this role:

- Learning operations of Automated Cell
- The setup and recipe changes required when changing product model
- Calculating and setting machine controls to regulate machine operation
- Contributing to daily, weekly and monthly preventative maintenance
- Maintaining the highest standard of quality control

The new members of our CFT team will possess:

- A strong commitment to following safe work practices
- Be mechanically minded
- Good communication and problem-solving skills
- A current Drivers Licence
- Ability to work within a team and autonomously
- The ability and willingness to work rotating shifts
- Experience with reading and understand[ing] engineering drawings is advantageous but not essential
- Experience working in a manufacturing environment is advantageous but not essential
- Forklift licence is advantageous but not essential

If you feel as though you have the relevant skills and the drive to work within a fast developing, diverse and ever-changing company apply today by following the link below.

Skillinvest is currently recruiting of behalf of O'Connors Farm Machinery for a 1st Year Apprentice to work at their Horsham branch.

This position represents an excellent opportunity for a self-motivated person wishing to commence a career in both the automotive and agriculture industries. Precision agriculture is one of many modern farming practices that make production more efficient. With precision agriculture, farmers and soils work better, not harder. There is a lot of technology used to make modern agriculture more efficient, such as GPS. The successful applicant ideally should possess the following attributes:

- GPS
- Farm Computer Software
- Drones
- Modern Farming Practices
- Computer experience
- Be able to problem solve
- The ability to work in a team environment with a friendly and positive ‘can do’ attitude
- Be reliable, honest and trustworthy and punctual at all times
- Commitment to complete your apprenticeship
- Be eager to learn and follow instructions
- Ability to demonstrate customer service values

Snapshot: current NCVER project: The fourth industrial revolution – technological disruption implications for Australian VET[4]

While there is growing consensus about the impact of this disruption to business models, sharp polarisation exists between those who see these technologies offering limitless new opportunities versus those who see major job dislocation. This uncertainty and lack of agreement have slowed down adaptations among corporations, governments and communities, which has subsequently hampered proactive changes in the VET sector.

This NCVER research (Pi-Shen Seet et al. forthcoming) aims to navigate through this paradox by moving beyond the technological drivers of change to focus on the anticipated skills needed from the perspective of both the innovators (technology producers) and industry (technology users). It has a particular focus on the future skills required from Australian VET graduates in the next five to ten years. This is in line with the need for future research to focus on the link between innovations with more fine-grained occupational characteristics.

In so doing, it will examine the relationships between emerging technologies and skills and will delve below the aggregate technological forces of employment change. The aim is to uncover important nuances and variations in existing and new occupations, job family levels and at required skills levels in the Australian context.

The main research topic is: how does disruptive technology relate to future skill development (and vice versa) in the VET sector, as seen from the innovators (technology producers) and industry (technology users) perspectives.

The results are expected to be published in early 2018.

4 Project Selection Committee — June 2016 NVETR Funding Round, project 55002.

Challenges, opportunities, limitations and strategies to reinvigorating apprenticeships to meet the demands of Industry 4.0

Apprenticeships have an honourable, well-respected and enduring history in Australia, and that reputation remains true today. However, apprenticeships face several challenges, along with opportunities, in meeting the demands of Industry 4.0. In this section we briefly look at the pool of apprentices and the role of employers and training providers — the three main stakeholders to the apprenticeship contract. As NCVER's *Future of Australian Apprenticeships Stakeholder Forum* confirmed, there is an identified need for a continued focus on the employment relationship in training.[5] Particularly needed is the integration of on- and off-the-job training, and the strengthening need for the tri-partite involvement and commitment of the employer, apprentice and training provider (Couldrey & Loveder 2017).

Pool of apprentices

The challenge in reinvigorating apprenticeships for Industry 4.0 is magnified by the fact that increases in the number of young people going on to university study after school have affected the pool of young apprentices. More young apprentices now come from low socioeconomic backgrounds and with lower academic ability, including literacy and numeracy deficits (Karmel, Roberts & Lim 2014). This means policy needs to provide resources and supports for helping them to remain in training and to enhance completion — they have signalled their preference for this VET pathway and so are the 'low-lying fruit' for raising apprenticeship and traineeships (see the earlier section *Setting the scene: latest apprenticeship data*), but only if they can be supported to completion. The question then remains for how VET, and the apprenticeship system, can stay attractive to those considering university study (but note that higher education also has completion problems for enrolments), in view of the easier access to universities and the greater value placed on this path by society (Roos 2017).

A significant opportunity and challenge exists in relation to how the whole of the VET sector can work collaboratively to raise the profile of apprenticeships and the reputation of vocational careers and pathways. This includes applying new thinking on how to effectively reach and inform the key influencers for young people — parents, career professionals and classroom teachers (Couldrey & Loveder 2017).

5 *The Future of Australian Apprenticeships Stakeholder Forum* was hosted by NCVER in conjunction with the Australian Government Department of Education and Training in Canberra on 25 October 2016. The forum was attended by over 60 key stakeholders from across the VET sector, including representation from the business community, industry peak bodies, unions, training providers, government agencies, and VET researchers. Discussions were structured around three main themes: benefits and value; attraction; and retention and completion.

Snapshot: Pathways in Technology (P-TECH) Program
<http://www.ptech.org.au/>.

The P-TECH pilot is an innovative model of education–industry collaboration, providing students undertaking their senior secondary certificate with an industry-supported pathway to a STEM-related diploma, advanced diploma or associate degree. The P-TECH pilot involves the establishment of long-term partnerships between industry, schools and tertiary education providers to enable businesses to play an active role in the learning and career development of their future workforce. This includes mentoring and providing pathways from school to further education, training and employment, including opportunities for employment with the school's industry partners. The model features opportunities for students to connect and build relationships with industry partners and engage in hands-on, project-based activities, both at school and in the workplace. These experiences will help students to make informed decisions about their future careers and pathways.

Local employers include: IBM, Barwon Health, GMHBA, Bendigo Bank, Tribal Campus, Opteon Group, Sanitarium, Mars, PwC, Austal, Defence Teaming Centre, Varley Group, BAE Systems, Century Engineering, Jetstar Airways, Ampcontrol, Ergon Energy, Wilmar Sugar, Canegrowers Burdekin, Jayben, Maltec Engineering and the Elphinstone/William Adams Group (CAT).

Role of employers

Teaching, training, coaching and mentoring are the central plank of apprenticeship systems and here employer involvement is crucial. This entails greater effort in ensuring that employers understand how much the culture of the workplace as a learning site matters. Employers should be more involved in deliberations about the type of learning their apprentices require. There is a need for strategies which engage small enterprises more holistically in the apprenticeship system and which identify how widely the support services offered through the Australian Apprenticeship Support Network and third-party intermediaries are recognised and utilised (Couldrey & Loveder 2017).

Employer (and apprentice demand) for fast-tracking skills development

This emphasis on the employer role and their needs is a strong theme emerging from the Engineering Excellence project, managed by the AiGroup to help RTOs to develop and implement systems that allow apprentices to progress through and complete their apprenticeship on the basis of achievement of competency (in engineering trades). The blunt message from the AiGroup, 2015 (p.53)[6]:

> It is a common belief for many in the VET system, especially within public providers, that the real customer they service is government. Government provides the funds and sets the rules. Teachers need a better understanding of their role in the system including that that they are in a service industry and their livelihood depends on keeping customers satisfied, and that there is no apprenticeship without an employer.

NCVER's data confirm the increasing prevalence for a trade apprentice to complete in a shorter timeframe, rather than the 'typical' four-year contract. Indeed, the proportion of adult apprentices completing a trade apprenticeship in two years or fewer has increased markedly over time, from around 28% in 1996 to over 50% in 2016 (Hargreaves, Stanwick & Skujins 2017).

Competency progression is of course not a new phenomenon in Australia; however, there remains a disparity between this approach and that of the time-based philosophy underpinning apprentice training.

6 See recommendations for further reading *Business beyond broadband: are Australian businesses ready for the fourth industrial revolution?*.

Clayton et al. (2015) investigated how the policy on competency progression and completion has been implemented in three trade qualifications: commercial cookery, engineering (metal fabrication) and carpentry. Their analysis identified uneven levels of support for the policy and a lack of provider flexibility in adopting the administrative, teaching and assessment approaches that facilitate progression and completion. They also identified that VET language blurs communication, and that training providers working with a large number of small employers do not have the resources to get to know the nature of the business in depth.

To be useful, apprenticeship training plans must be living documents, with change incorporated as needed. With the advent of digital tools to aid assessment, apprentices now need to take considerable responsibility for collecting their assessment evidence. The authors conclude that not only does competency progression demand strong provider—employer cooperation, but that such progression and early sign-off are appropriate only for 'the most gifted apprentices or those who are mature-aged and come with prior work experience' (Clayton et al. 2015, p.10).

A recent NCVER project investigated an alternative pathway to accelerate completion, namely, the use of recognition of prior learning (RPL) to identify existing skills and knowledge in combination with gap training. Hargreaves and Blomberg (2015) found that use of RPL as a means of fast-tracking adult apprentices was still not widespread. This is related to, inter alia, a prevailing culture of time-based progression and the cost of RPL. They observe that, when RPL is made available, it is important that eligible apprentices and their employer do fully understand the process.

Employer demand for higher skills and higher apprenticeships

Extending the concept of apprenticeships to higher-level qualifications, such as diploma and associate degrees, is seen as a logical progression of the Australian model to meet the needs of the fourth wave of industrial development and to ensure we are preparing for the skilled workforce of tomorrow (Couldrey & Loveder 2017). A more flexible and responsive apprenticeships system is also essential to support evolving labour market demands. Higher apprenticeships have the potential to respond to the skilling needs of growing high-skill industry sectors by combining on-the-job training with advanced-level training.

Skills ministers of the COAG Industry and Skills Council have agreed that an area of focus in apprenticeships is the development of strategies to improve the status of apprenticeships. Opening up higher apprenticeships pathways, which involve collaboration between employers, registered training organisations and universities, can assist in lifting the status of apprenticeships as a valued career path. Industry stakeholders are calling for higher-level apprenticeships. The Australian Industry Group, Australian Chamber of Commerce and Industry and Business Council of Australia have called for an apprenticeships system that develops contemporary, relevant and higher-level trade and para-professional skills across the economy.

Significant reforms in the United Kingdom demonstrate the potential of the higher apprenticeships model, with higher apprenticeships graduates rated as more employable (Couldrey and Loveder 2017). Higher completion rates, better staff retention, and strong return on investment for government are among other advantages. The UK approach is concerned with encouraging higher or degree apprenticeships in areas such as advanced technology, construction and digital media, with opportunities intended to attract students not going to university. The entry standards are higher than traditional apprenticeships, with off-the-job training blending both vocational and university courses. Under the Trailblazers program, this is coupled with collective industry input into apprenticeships with a higher-quality design.

Small-scale trials of higher-level apprenticeships are underway in Australia (see box below), but further scoping work and research are required at a national scale to understand the potential for broader application of the higher apprenticeships concept. NCVER is currently undertaking a project which will research international practice and Australian perspectives on the potential for, and barriers and possible solutions to, higher apprenticeship models. The project will focus on industry and government jurisdiction perspectives on differing higher apprenticeship models and their application to an Australian context. The results are expected to be released early 2018.

Snapshot: Industry 4.0 higher apprenticeship pilot project

The project utilises an apprenticeship framework to deliver a new Diploma and Associate Degree in Applied Technologies. The aim is to create an apprenticeship model that will support the higher skills needed for Industry 4.0. The project is led and managed by the AiGroup and will be implemented in collaboration with Siemens Ltd and Swinburne University of Technology.

The program will enable employers to train future technicians to the higher skills level required to meet their increasing needs in the knowledge economy. Up to 20 school leavers will be employed as apprentices at Siemens for the duration of the project, from 2017 to 2019, inclusive. Swinburne University of Technology will design and deliver the program, which will include a range of elements, including Industry 4.0 and the Internet of Things, IT Disruptive Technologies, Engineering, Design and Business. The program will directly articulate into a bachelor's degree, which will also be developed during the life of the project. It is anticipated that the majority of the program will be delivered in the workplace and be supported by the latest digital platforms.

The project will provide higher-level qualifications and appeal to a broader cross-section of young people than the apprenticeship model does currently. The young people will gain these qualifications while working in a company that is a technology leader. The qualification will meet the particular needs of industry, with a focus on the adoption of high-level technology skills and the tools required for the future workforce. The qualification brings together key industry initiatives and policies such as the National Science and Innovation Agenda and the Growth Centres initiatives into a practical experiential learning environment to address real industry needs. The pilot combines the best of university and vocational learning models and aims to improve the STEM skills of technically minded participants. It also incorporates skills for the new millennia in business and design (Lilly, in Couldrey & Loveder 2017, p.28).

Advanced Apprenticeship Program – Industry 4.0
SIEMENS – Melbourne, VIC

Any Industry
Imagine working in a company where your innovation and creativity can make a positive impact on the world around you while you study a Diploma of Applied Technologies. At Siemens we focus on the biggest challenges facing Australia and New Zealand and provide technology based solutions for Water, Energy, Environment, Healthcare, Productivity, Mobility, Safety and Security.

Siemens is one of the largest and most successful electrical engineering and electronics organisations in the world. Operating across many different industry sectors, our technology products and services touch almost all of our lives in some way every day of the year. Join us and discover how you can make a difference. In collaboration with Australian Industry Group and Swinburne University, Siemens is hosting 20 apprentices to be immersed and educated for the next industrial revolution. Industry 4.0 is driven by digitalisation and is the next frontier in manufacturing. It introduces higher levels of automation and data exchange into the manufacturing process and includes cyber- physical systems, the internet of things and cloud computing.

The successful 20 candidates will be employed by Siemens on an 'Apprentice Learning Model' where they will be earning an income while they are placed at Siemens in Bayswater and while studying at Swinburne at their Hawthorn campus.

Who we are looking for:

Our Apprentices are motivated, enthusiastic and flexible. They're passionate about engineering, making a difference, and the opportunity to learn about emerging technologies and practices. If this sounds like you, then we'd love to hear from you.

Role of training providers

Meanwhile, there is plenty that training providers can do to cater for the new world of work and its skills requirements. *The future of work jobs and skills in 2030,* published in 2014 by the UK Commission for Employment and Skills, offers education and training providers some pointers to action, many of which apply to the Australian context:

- collaborate closely with employers to support them in achieving their business and skills objectives and so ensure provision is responsive to their needs and forward-looking in a competitive learning market
- be prepared to adapt to the continuing disruption of established income streams and business models arising from the marketisation of learning
- invest continuously in new modes and content of provision, keep abreast of developments and understand the impact of technology on learning delivery
- put in place systems to offer clear information on success measures of learning to inform investment decisions by learners and employers
- adapt learning programs to reflect the critical importance of an interdisciplinary approach to innovation in the workplace and the all-pervasive influence of technology
- understand the increasingly diverse demands people place on modes of education and training and develop flexible learning pathways and bite-sized opportunities to reflect the changing employment landscape (UK Commission for Employment and Skills 2014, pp.108—9).

An AiG report (AiG 2015) recognises the obstacles that RTOs face in implementing new models, including changing policy and funding regimes, cutbacks in staff and industrial relations constraints (p.7). But its recommendations do not address the issue of cost which remains to be detailed. Among the strategies it does suggest are (pp.6—7):

- have training plans that are suited to the apprentice's workplace and fit in with the industrial award. To ensure the plans reflect what the apprentice does at work, RTO-developed equipment checklists that suit the workplace and where necessary open discussions about how an employer can confirm the assessment should be encouraged.
- seek confirmation of competency from employers by using paper-based or electronic systems such as My Profiling (a patented online system for tracking student workplace activity), which facilitate record keeping about the tasks completed, RTO assessment and employer agreement that the workplace standard has been met.
- interpret training system 'speak' into the language of industry and give employers more information about their apprentices' progress to help them to monitor their progress and pay the correct wage.

In their submission to a recent parliamentary inquiry, a large Australian private provider suggested that providers could better respond to the changing demands of the new economy if:

- the number of listed electives in training package qualifications was reduced to one-third of the total units to enable room for genuine electives
- the Australian Skills Quality Agency's timeframe for approving new courses was reduced to enable more rapid accreditation of new courses

- the number of government-subsidised students whom low-risk VET providers can enrol was uncapped
- Commonwealth Supported Places were extended to AQF level V and VI courses, as these are programs often undertaken by learners who are already working and looking to upskill or reskill
- the credit students can receive for prior VET courses was standardised to avoid their having to pay to re-do previously completed courses.

Stanwick, Circelli and Lu (2015) also further identified important considerations relating to training that need particular attention as a result of industry restructuring:

- committed resources from providers
- the ability and capacity to tailor skills-recognition activities
- sufficient numbers of ongoing courses to meet demand.

To cater for Industry 4.0 it is important that training in apprenticeships will, wherever possible, facilitate the transferability of existing skills.

Potential limitation: Australia's innovation system and culture

In relation to innovation Australia is ranked twenty-third in the world, according to the Global Innovation Index. While this is a modest performance, it is somewhat concerning that the country has dropped four places from last year.[7] Importantly for industry global market roles, Australia is outperformed in the region by Singapore, Korea and China, as well as New Zealand (table 2). It would appear that Australia's regional neighbours are doing it far better, and we still have a long way to go to catch up to our regional and global counterparts.

Table 2 Regional innovation leaders for Southeast Asia, East Asia and Oceania, Global Innovation Index 2017

Region/rank	Country	Global Innovation Index 2017 Global Rank
1	Singapore	7
2	Republic of Korea	11
3	Japan	14
4	Hong Kong (China)	16
5	New Zealand	21
6	China	22
7	Australia	23

Source: The Global Innovation Index (2017).

While Australia scored quite strongly and well above average on innovation inputs, coming in at 12, it is underperforming in terms of innovation outputs — the innovations it produces — ranking at only 30.

In essence, Australia has many of the needed elements in place to be a more innovative economy, such as a reasonably strong skills base and some high-quality research and development institutions. Yet, performance is less than other economies. According to the Global Innovation Index report, there are 256 state and territory programs and 83 federal government measures that aim to boost innovation in Australia. As innovation policy expert Roy Green points out, Australia has had 60 reports

7 However, note that the rankings are not strictly comparable as there have been adjustments and refinements to the framework and technical factors over the years and four countries included in 2016 dropped out, while three new countries were introduced.

at the Commonwealth level on innovation in the last 15 years. The $9.7 billion the country spends on 'research and innovation' is spread across 13 portfolios and 150 budget line items.[8]

A snapshot of the Australian Innovation System is provided in figure 4.

Innovation has become increasingly important for Australian businesses in enabling them to continue to compete in an international market, but where does VET sit in this?

Until recently, the VET sector has been little connected into the Australian Government's National Science and Innovation Agenda (NISA). The agenda demonstrates the federal government's commitment to fostering innovation as an essential component in driving Australia's economy. The VET sector presents many opportunities for nurturing innovation; however, this is currently under-acknowledged in NISA, where funding through this initiative is largely aimed at the university sector.

The House of Representatives has recently released its report on innovation and creativity (Australian House of Representatives Standing Committee on Employment, Education and Training 2017), and some of its recommendations relate to specific elements of this research, in particular:

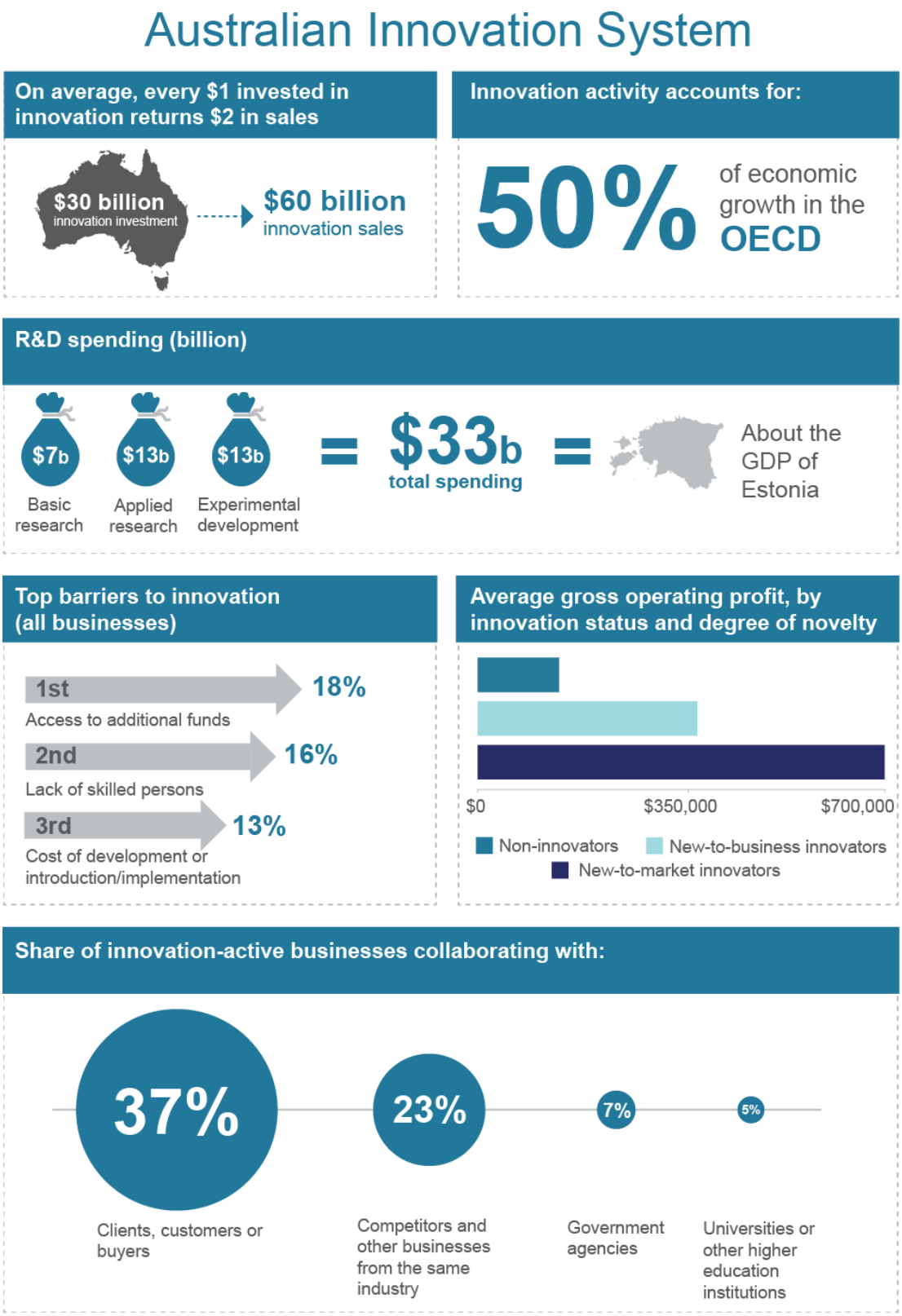
- expanding the National Innovation and Science Agenda to include the VET sector (Recommendation 16)
- adopting elements of the Canadian Applied Research and Innovation Services model to strengthen connections between VET providers and small- and medium-sized enterprises (Recommendation 29).

NCVER is working consultatively with the Commonwealth Office of Innovation and Science Australia on the Innovation, Science and Research System 2030 Strategy to ensure issues pertinent to VET are captured.

Recent research by NCVER (Beddie & Simon 2017) also suggests there is an opportunity for the VET sector to be a contributor to the innovation system through an applied research agenda. In this context, it refers to VET being oriented toward a focus on solving real-world problems. Through its ties to industry, VET can play a role in translating this knowledge to the workforce. RTOs do not need to start from scratch to be involved in the innovation agenda: they can build on their existing business models to develop innovation within industries. Other possibilities include capitalising on their infrastructure, expertise and community connections, or hosting innovation hubs or enterprise incubators. Many practitioners already possess the skills relevant to applied innovation work with industry, but these need to be further developed, either by their practising them or undertaking professional development. The VET applied research developmental framework proposed by Beddie and Simon (2017) can help to determine the additional skills needed that can then be supplied through professional development of VET trainers.

8 <http://www.theaustralian.com.au/business/opinion/innovation-critical-to-boosting-productivity-in-tough-times/news-story/5860a36fb64279c1d5b9517469156df2>.

Figure 4 The Australian Innovation System



Source: Source: ABS (2016) *Innovation in Australian Business 2014–15*, cat. no. 8158.0; OECD (2015) The OECD Innovation Strategy 2015, OECD Publishing; ABS (2016) Customised ABS data commissioned by the Department of Industry, Innovation and Science; ABS (2015) *Research and Experimental Development, Business, 2013–14*, cat no. 8104.0; ABS (2016) *Government and Private Non-Profit Organisations*, 2014–15; ABS (2016) *Higher Education Organisations*, 2014, cat no. 8111.0

Source: Office of the Chief Economist (2016).

Snapshot: Australian House of Representatives Standing Committee on Employment, Education and Training inquiry: Innovation and creativity: workforce for the new economy

In May 2017 The House of Representatives Standing Committee on Employment, Education and Training delivered a report following their inquiry into whether Australia's tertiary education system – including universities and public and private providers of vocational education and training – has the capability to meet the needs of a future labour force focused on innovation and creativity.

The inquiry had particular regard to:

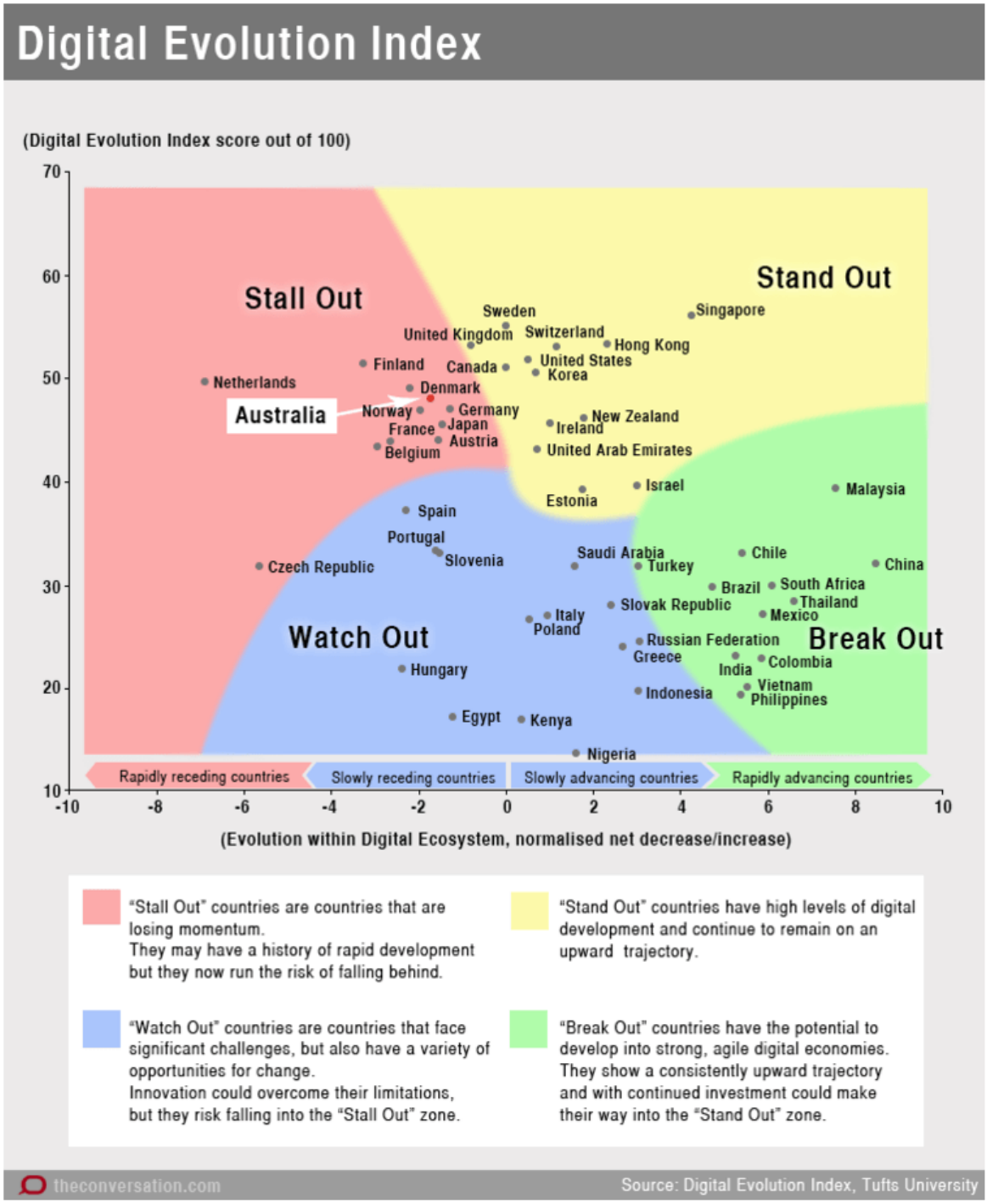
- the extent to which students are graduating with the skills needed for the jobs of today and of the future
- matters relating to the laws and regulations that may act as a barrier to education providers being able to offer qualifications that meet the needs of the new economy and fastest growing sectors
- factors that discourage closer partnerships between industry, in particular small- and medium-sized enterprises, the research sector and education providers, including but not limited to intellectual property, technology transfer, doctoral training practices, and rapid commercialisation
- opportunities for generating increased economic activity, including further investment and jobs through greater synergies among publicly funded research agencies, universities and other Australian research institutions with businesses and industry, including but not limited to co-location, cluster formation and development of precincts between universities and industry
- relationships between tertiary education entrepreneurship programs and public, private, and not-for-profit incubators and accelerators.

The findings and recommendations can be found at: <http://www.aph.gov.au/Parliamentary_Business/Committees/House/Employment_Education_and_Training/Innovationandcreativity/Report_-_Innovation_and_creativity>.

Australia's digital economy has stalled

The government had acknowledged the need for Australia to transition its economy, but research from Tufts University (2017) suggests we have stalled. While the nation has achieved a high level of progress towards becoming a digital economy in the past, we are at risk of falling behind. The research argues that 'stall out' countries such as Australia can only jumpstart their economies by redoubling their efforts on innovation and continuing to seek markets beyond domestic borders. It also says attracting highly talented young immigrants could help to revive innovation (figure 5).

Figure 5 Digital Evolution Index



Source: Tufts University 2017, The digital evolution index — 2017, New York.

A current NCVER research project (Gekara et al. 2017) is aiming to identify the digital skills requirements for the broader Australian workforce and examine the capacity of the VET system and industry training packages to effectively meet the growing need for digital skills.[9] As part of the project's outputs, the study will develop a replicable methodology for reviewing the alignment between skills needs and training capacity, as well as propose a digital skills framework to guide the development of adequate and appropriate digital skills for the emerging digital economy.

For the purpose of the study, digital skills were defined as a combination of a digital mindset (hardware, software, information, systems, security and innovation), knowledge (theoretical comprehension and understanding), competence (cognitive and practical knowhow) and attitude (value and beliefs). The following represents some of the findings to date (from the Gekara et al. 2017 working paper, the final report is expected in 2018):

From the online job-vacancy skills analysis a number of key observations are made:

- Of the 1708 jobs searched, only 204 job vacancies across all of the selected occupations specifically mentioned digital skills. This poses important questions about employers' articulation of digital skills and how well they are explicitly stated rather than perhaps assumed. This is important, considering that industry evidence suggests that occupations are changing as the economy enters a digital age, one characterised by sophisticated efficiency and productivity-enhancing mechanical and digital technologies.
- Even in the job advertisements where digital skills were specifically mentioned, the level of expected application is largely vague and mostly basic. Employers used descriptions of expected performance like 'strong', 'good', 'sound', 'solid' and 'basic'. This suggests that employers are not clearly articulating their specific skills needs.
- Additionally, employers seem to require a very basic level of skills: mostly basic computer operations and digital literacy. However, the researchers identified some trends in terms of skill levels and digital tools across industries and occupations, and across position levels (for example, managers/professions and technical/trades).
- It is also evident that employers tend to conceptualise and articulate digital skills from a tools perspective. Instead of listing the skills they require, they simply describe the tools they would like prospective employees to be able to use and operate.

The digital skills training content analysis of the 11 training packages reveals a number of important findings:

- The VET system clearly contains a significant amount of digital training content, spread across different units of competence.
- However, a large number of these units of competence are elective rather than core to the qualifications of the respective occupations. While this provides greater flexibility for training providers, trainees and employers, it suggests that perhaps the training system is not according digital skills the same 'essential skills status' as would be expected, considering their growing importance.
- Digital training content in the training packages is expressed broadly and generically, with little reference to specific tools and systems. This is done deliberately, with the aim of making the

9 Project Selection Committee — June 2016 NVETR Funding Round, *Developing appropriate workforce skills for Australia's emerging digital economy,* Project 55007.

package flexible and adaptable to the wide variety of workplace tools and systems used by different industries across the sectors.

- It also shows that the training is more geared towards developing skills at the lower skills end; that is, for the basic use of computer hardware and software in processing data and information from organisational databases, as well as for online internet and web sources. This is counter to growing industry evidence of an increasing need for higher-level skills in data analytics, cyber-security, social media and mobile-related digital skills.

Digital technologies are increasingly interwoven into all parts of our lives and impact on the social, economic and environmental wellbeing of individuals as private citizens and as workers. As digital skills become essential in all work settings, there is an assumption that people training for and entering higher-skill occupations already possess the necessary digital skills. It is increasingly evident that the general workforce, including those engaged in low-skilled occupations, requires digital skills to navigate through workplaces that are becoming highly mechanised and digitised. This inevitably shapes the ways in which trainers, workers and employers come to perceive and define digital skills.

The digital skills training need is evident for all occupations across all sectors and at all levels. Interestingly, there appears to be substantial digital skills content in the lower-skills occupations; that is, in operational and non-supervisory as well as in higher-skills occupations such as managers.

One aspect of digital literacy is the basic use of computer hardware and software in processing data and information from organisational databases, as well as for sourcing information and social media. Social media is used in vocational education and training as a tool to provide course information and for asking questions, to collaborate on group assignments and to demonstrate skills that have been learned. The use of social media in VET courses can lead to higher levels of student engagement, promote more collaborative learning and may encourage increased rates of course completions. It may also equip VET students with the digital skills needed in the workplace. The recent NCVER publication *Social media in VET courses: good practice guide* is based on research by Victor Callan and Margaret Johnston, and shows how social media can be incorporated in VET training and assessment. Encouraging this and broader adoption across VET may enhance digital skills for Australians.

Conclusion

While Australian governments' policies related to apprenticeships are yet to specifically embrace strategies for Industry 4.0, there are a number of broader initiatives underway, as outlined in this paper. These include, for example, a current and concerted focus on higher apprenticeships. However, there are also a number of other factors and challenges at play which cannot be ignored. A key concern for Australia is that to date the VET sector has largely being overlooked in the National Innovation and Science Agenda. Innovation has become an increasingly important concept for Australian businesses, in that it enables them to continue to compete in an international market. Indeed, the path to prosperity brought about by the fourth industrial revolution will be through innovation. The pivotal role of the VET sector — and apprenticeships — in this area needs to be acknowledged and supported. In addition, policy on higher education reform focusing on universities has inadvertently impacted on the pool of apprentices. A significant challenge for Australia is the reimagining of sectoral boundaries and addressing perceptions of the nature of university and vocational pathways. With the deep connections between industry and employers, as well as the role of vocational training providers, Australian apprenticeships have an even greater role to play as a linchpin connecting tertiary education with industry.

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